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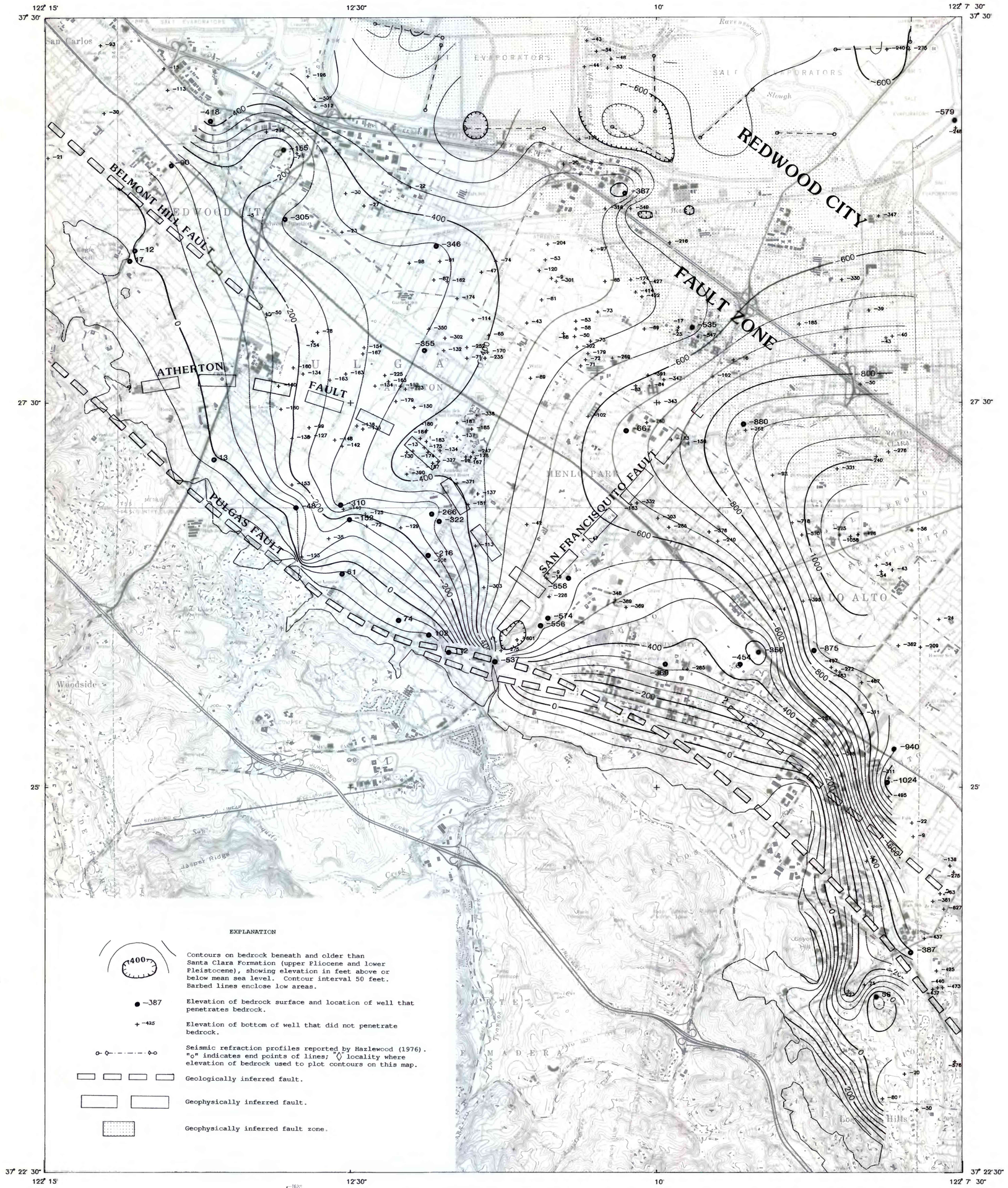
SHEET 1 OF 3



SHEET 1. Map showing elevation of the bedrock surface beneath the flatlands of Menlo Park, Atherton and adjoining areas, California

By

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PRELIMINARY GROUND WATER QUALITY DATA AND THE EXTENT OF THE GROUND WATER BASIN FROM DRILL HOLE, SEISMIC, AND GRAVITY DATA IN THE PALO ALTO 7.5' QUADRANGLE, CALIFORNIA

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INTRODUCTION

This map displays part of the information requested by the City of Menlo Park to assist them in determining the location, quality, and quantity of ground water. Information for the map was derived largely from confidential water well reports at the California Department of Water Resources archives in Sacramento, from U.S. Geological Survey water records and unpublished data, and from water well records at Stanford University and the City of Palo Alto. A few records were obtained from reports by Wood (1975), Rogenson and others (1967), Sokol (1964), Poland (1970), and the California Water Commission (1955). The map by Hazlewood (1976) derived from the interpretation of seismic refraction profiles was used to determine the elevation of the bedrock surface in the area of salt evaporators north of Bayshore Freeway.

PROCEDURES

All of the water well information was organized by township, range and section. The location of each well was checked on published and unpublished maps or in the field. In many instances, the wells could not be accurately located and were omitted. Other wells are only approximately located within about 1,000 ft. Many more wells probably exist in the area of this map that have never been reported to State or local agencies.

The elevation of the bedrock surface in those wells that penetrated bedrock was derived by subtracting the depth to bedrock from the elevation of the well on the well log or on elevation estimated from the topographic map. These elevations are probably accurate within 10 ft, except for those in wells in Table 1 where the identification of the bedrock is queried. For those wells that did not penetrate bedrock, the elevation of the bottom of the hole was determined by subtracting from the total depth of the hole the elevation of the well at the surface.

Contours of the bedrock surface elevation were drawn by machine using a computerized algorithm which finds a surface of minimum total curvature, or the smoothest surface consistent with the data. This algorithm produces a contour map which makes the most neutral mathematical assumption, smoothness and flatness, in areas where no data are provided. The computer code is from the Surface Gridding Library, prepared by The Software Development Group, Dynamic Graphics, Inc., Berkeley, California.

An unpublished topographic and well location map prepared in 1931 by someone at Stanford University, possibly J.F. Poland, shows elevations for wells in the Palo Alto, Menlo Park, and Atherton areas that are as much as 15 ft higher than elevations on the 1961 U.S. Geological Survey 7.5' quadrangle. Poland (1969, 1971) determined that subsidence in the Atherton and Menlo Park areas from 1934 to 1967 was only about one foot, so nearly all of the elevation differences are probably related to errors in preparation of the different topographic maps. Subsidence was not taken into account in the preparation of the bedrock surface map because it is so small.

Faults that might affect the bedrock surface within this map area have been added from data largely independent of the wells. The Belmont Hill fault has been tentatively extended south into Redwood City from surface exposures mapped by Pampeyan (1981) and Brabb and Olson (1986) in the Belmont and San Carlos area approximately 3 miles northwest of the western border of this map. Another inferred fault in Palo Alto roughly parallel to Hanover Street could be a southerly extension of the Belmont Hill fault, but well data in between are not sufficient to link these features. The fault near Hanover Street is inferred from a northeast-facing escarpment about 20 ft high, and from the generally very deep elevation of the bedrock surface northeast of this escarpment and the occurrence of bedrock close to the surface southwest of the escarpment.

The Pulgas fault is here named for a structure with a northeast-facing scarp about 20 ft high in southeastern Atherton along Alameda de las Pulgas. In that area, the fault has offset alluvium considered by Helley and Lajoie (1979) as late Pleistocene age. This fault was also recognized by Dibblee (1966). The fault splits in the area near San Francisquito Creek where sedimentary rocks of Cretaceous age are in fault contact with sedimentary rocks of Eocene age to the southwest and with at least 700 ft of sediment of late Cenozoic age to the northeast. Both strands of the fault were exposed in the 1960's but have since been covered with rip rap and debris. Both strands apparently merge southeastward into the Stanford fault zone as mapped by Brabb and Olson (1986). This zone of geologically young thrust faults was considered by them to be seismically active, and to possibly offset Holocene alluvium. The hazard, if any, associated with these faults has not been established.

The Redwood City fault was named by Brabb and Hanna (1981) for an aeromagnetic anomaly extending northwestward approximately 16 miles from Palo Alto through the shoreline area of Redwood City. The fault is inferred from the linear character and steep gradient of the magnetic anomaly. Brabb and Hanna used a line to depict the fault at 1:125,000 scale, but at the 1:24,000 scale of this map, the fault covers a zone more than 2 miles wide. The aeromagnetic anomalies and gravity measurements associated with the fault zone indicate that the rock is mainly serpentinite. No hazard has yet been associated with this inferred fault.

The Atherton and San Francisquito faults are inferred from gravity measurements, and are discussed in another section of this report.

INTERPRETATION

Identification of the material and geologic formation from data provided by drillers is highly subjective. A 1927 log of a well at Sequoia High School in Redwood City, for example, indicates that the driller penetrated more than 200 ft of granite, blue slate, and black rock before encountering sandy clay, blue sand, and more granite and slate. These geologic relations and rock types are highly unlikely, judging from geologic maps of that area by Pampeyan (1970) and Brabb and Pampeyan (1983) and from data in nearby wells. Our interpretation is that the so-called granite and black rock are probably different volcanic rocks within the Franciscan assemblage of Jurassic and Cretaceous age, and that the so-called slate represents shale within this assemblage. The sandy clay and blue sand could be shale and sandstone of the Franciscan assemblage that have been softened by tectonic shearing or weathering.

Information about the character of bedrock encountered in the principal wells used to construct the bedrock surface map is provided in Table 1. Note that the terms used by the drillers to describe the bedrock and our interpretation of the geologic unit involved are both provided.

We were not successful in identifying the Santa Clara Formation of late Pliocene and early Pleistocene age in any well. This unit has poorly consolidated sandstone, mudstone and conglomerate that is distinguished from surficial deposits of Quaternary age in outcrop mainly by the amount of deformation the unit has undergone. The term "bedrock" as used on this map, therefore, is applied to units stratigraphically beneath and older than the Santa Clara Formation.

Wells to bedrock north of a line extending south-southeast from outcrops of the Franciscan assemblage on Eagle Hill in Redwood City to the U.S. Geological Survey center in Menlo Park and beyond encountered mainly a hard shale that we interpret as the Franciscan assemblage. In the southern part of Redwood City, Atherton, and Menlo Park, the wells penetrated soft "shale" and interbedded sandstone that are here assigned to an unnamed sandstone, claystone and siltstone formation of early and middle Eocene age. This unit was referred to as Butano(?) Sandstone on the map by Brabb and Pampeyan (1983). Some of the rocks could also be interpreted as those of the Franciscan assemblage. In the area of the central part of Stanford University southeast to the U.S. Veterans Hospital and beyond, the wells penetrated sandstone, shale, conglomerate and fossil shells that are probably from an unnamed formation of middle and late(?) Miocene age. For additional information about these geologic units, refer to the map by Brabb and Pampeyan (1983).

Spacing of wells to bedrock is not sufficient to determine which features outlined by the contours are related to tectonism, erosion, errors in the data, or errors in interpreting the data. The abrupt change in elevation from bedrock at the surface along San Francisquito Creek near Oak Knoll School to −537 ft is probably caused by movement along the Pulgas fault. The relative sense of movement is the northeast block down, but thrusting and/or lateral movement are also possible. The rounded, structurally-high areas near Chestnut Street in Redwood City and Palo Alto High School in Palo Alto are probably underlain by erosional remnants of bedrock like Eagle Hill in Redwood City and Coyote Point in the northern part of San Mateo County. Some of the structually low areas could be related to valleys carved by San Francisquito Creek and other creeks thousands of years ago, or to tectonic downwarp. Alluvial deposits along the middle of the possible valleys would probably be thicker, coarser-grained, and more permeable.

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Beilin and Knifong are further acknowledged for digitizing the well information and for preparing preliminary copies of the bedrock surface map.

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TABLE 1.-Wells in the Palo Alto quadrangle that extend to bedrock

CSWR No.[1]	Brabb No.[2]	Total Depth ft.	El. ft.[3]	Bedrock el. ft.	Bedrock lithology reported by driller	Our interpretation of geologic unit	Notes
None	1			−418	Shale	Shale in Franciscan assemblage	
5S/3W 19F80	2	376	18	−90	Slate, granite, hard blue rock, black rock, sand, clay	Shale and greenstone in Franciscan assemblage	Sequoia H.S.
5S/3W 20P1	4	383	6	−305	Hard shale, cemented gravel, hard rock	Shale and conglomerate in Franciscan assemblage	Bedrock possibly at −188 ft.
5S/3W 22J80	5	413	10	−387	Blue shale	Shale in Franciscan assemblage	Bear Gulch Water Co.
5S/3W 26K1	8	620	40	−535	Blue shale and clay	Shale in Franciscan assemblage	VA Hospital
5S/3W 28C1	10	450	34	−346	Blue shale	Shale in Franciscan assemblage	Bear Gulch Water Co.
5S/3W 28P1	11	422	50	−355	Sand, rock	Sandstone in Franciscan assemblage	
5S/3W 30D1	12	56	33	−12	Hard rock with streaks of quartz	Sandstone in Franciscan assemblage	
5S/3W 32Q1	14	409	80	−310	Blue shale, rock, yellow clay	(?) Unnamed sandstone and shale of Eocene age	
5S/3W 34H	17	1000	53	−667	Sheared shale, graywacke and fault gouge	Franciscan assemblage	USGS heat flow well--see Sass et al. (1968)
5S/3W 35G1	20	934	47	−880	Hard rock (limestone according to unconfirmed report)	Franciscan assemblage	Hale well, City of Palo Alto
6S/3W 3L1	25	746	85	−558	Blue rock, blue shale, blue clay, hard gravel	(?) Unnamed sandstone and shale of Eocene age	Listed by CWC (1955) p.45, 117
6S/3W 4C2	26	412	83	−322	Tough white clay	(?) Unnamed sandstone and shale of Eocene age	
6S/3W 4P1	27	308	88	−216	White and yellow clay	(?) Unnamed sandstone and shale of Eocene age	
6S/3W 9A2	28	698	115	−537	Blue clay and shale, hard rock	(?) Unnamed sandstone and shale of Eocene age	Stanford Univ.
6S/3W 12D1	29	950	35	−875	Hard blue sand	(?) Unnamed sandstone and shale of Miocene age	City of Palo Alto Peers Park well
6S/3W 12R1	32	1179	33	−940	Blue clay, gravel, rock	(?) Unnamed sandstone and shale of Miocene age	City of Palo Alto Fernando Well
6S/3W 13A2	33	1186	42	−1024	Blue clay, shale, sand, shells	(?) Unnamed sandstone and shale of Miocene age	City of Palo Alto Matadero Well
6S/3W 11A1	34	410	48	−356	Cemented clay and rock	(?) Unnamed sandstone and shale of Miocene age	J. Poland 7
6S/3W 11B1	35	828	52	−454	Sand, clay, rocks	(?) Unnamed sandstone and shale of Miocene age	Stanford Univ.
None	51	590	6	−579	Graywacke	Franciscan assemblage	USGS
6S/3W 5A	124	245	85	−152	Blue clay and shale	(?) Unnamed sandstone and shale of Eocene age	J. Poland 211
6S/3W 4C1	129	355	82	−266	White clay	(?) Unnamed sandstone and shale of Eocene age	J. Poland 215
6S/3W 3N2	131	690	96	−556	Blue clay and shale	(?) Unnamed sandstone and shale of Eocene age	Stanford no. 4
6S/3W 3N1	132	705	94	−574	Blue clay and shale	(?) Unnamed sandstone and shale of Eocene age	Stanford no. 3
6S/3W 11D	161	447	72	−369	Blue shale	(?) Unnamed sandstone and shale of Eocene age	Stanford arboretum
6S/3W 24M80	176	535	132	−387	Blue shale	(?) Unnamed sandstone and shale of Miocene age	
6S/3W 24M81	179	114	160	+56	Hard red rock	(?) Basalt of Miocene age	
5S/3W 30D	213	286	37	+17	Hard black rock	Franciscan assemblage, probably greenstone	
5S/3W 31J	214	120	73	+13	Shale	Franciscan assemblage	
6S/3W 4N	261	120	106	+74	Sandstone and shale with hard layers	(?) Unnamed sandstone and shale of Eocene age	
6S/3W 4P	262	120	110	+102	Soft sandstone	(?) Unnamed sandstone and shale of Eocene age	
6S/3W 5G	263	120	106	+61	Shale and rock	(?) Unnamed sandstone and shale of Eocene age	
6S/3W 9b	264	120	117	+112	Sandstone, shale and serpentine	Fault zone	
5S/3W 20F	272	193	9	−155	Hard rock and sandy shale	Franciscan assemblage	
5S/3W 32P	296	350	87	−48	Hard rocky shale; gray, blue and yellow	(?) Unnamed sandstone and shale of Eocene age	

[1]Well number used by the California Department of Water Resources.

[2]Arbitrary number assigned by E. E. Brabb.

[3]Elevation of well from well log or estimated from topographic map.